

Iterative phase retrieval in one dimension for studying confinement induced ordering in microfluidic arrays

Oliver Bunk¹, Franz Pfeiffer,¹ Ana Diaz,^{1,2} Christian David,¹ Bernd Schmitt¹, Dillip K. Satapathy¹, and J. F. van der Veen^{1,3}

¹Research Department Synchrotron Radiation and Nanotechnology, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland, ²Present address: European Synchrotron Radiation Facility, BP220, 38043 Grenoble Cedex, France, ³ETH Zurich, 8093 Zürich, Switzerland

Arrays of microfluidic channels lend themselves, e.g., to studying confinement induced ordering in model liquids or as orienting template for macromolecular small angle x-ray scattering (SAXS) studies in transmission geometry. We report on the microfluidic array phase profiling (MAPP) technique, focusing on iterative retrieval of one-dimensional complex-valued exit fields, and its application to studies of confinement induced ordering in model fluids.

The technique has several advantages. In contrast to traditional lensless imaging fully coherent illumination is not required. The ensemble averaged structure rather than individual realizations are investigated and thereby the dose on the specimen is reduced by orders of magnitude. By statistical averaging of solutions we show that the resolution is currently in the 10 nm range.

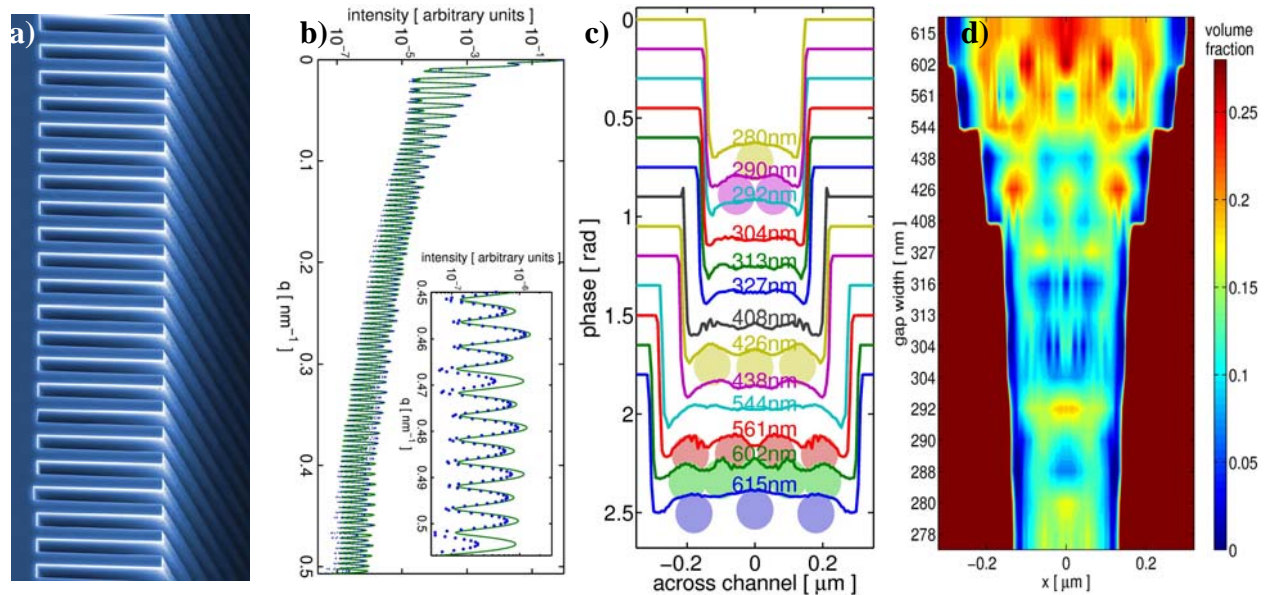


Figure 1: a) An array of microfluidic channels with a period of 1 μm . b) Measured and from the retrieved complex-valued field calculated grating diffraction intensities for a single array of 1.25 μm period and 615 nm channel width. c) Retrieved phase profiles of silica colloids (109 nm diameter) in microfluidic arrays. The profiles are offset vertically for clarity. The determined channel widths are shown for each profile, and layering, i.e., pronounced increased concentration is indicated by spheres. d) The silica concentration inside the microfluidic channels is shown as a contour plot for several channel widths. The excluded volume effect of 0% concentration at the confining walls as well as pronounced concentration increases due to the confinement are clearly visible. The dark red outer region is the area of the confining silicon walls.

References:

- [1] O. Bunk, A. Diaz, F. Pfeiffer, C. David, C. Padeste, H. Keymeulen, P.R. Willmott, B.D. Patterson, B. Schmitt, D.K. Satapathy, J.F. van der Veen, H. Guo, and G.H. Wegdam, *Confinement-induced liquid ordering investigated by x-ray phase retrieval*, Phys. Rev. E **75**, 021501 (2007).